CLAIMS

What is claimed is:

1. A pharmaceutical composition for oral delivery of an antimicrobial agent comprising:

   a) a biopolymer;

   b) an antimicrobial agent entrained within or ionically bound to the biopolymer; and

   c) a cationic binding agent entrained within or ionically bound to the biopolymer or the antimicrobial agent.

2. A pharmaceutical composition for oral delivery of an antimicrobial agent comprising:

   a) a biopolymer;

   b) an antimicrobial agent entrained within or ionically bound to the polymer;

   c) a cationic binding agent entrained within or ionically bound to the biopolymer or the antimicrobial agent; and

   d) an absorption enhancer.

3. The pharmaceutical composition of claim 1 or 2 wherein the biopolymer is selected from the group consisting of carrageenan, xylan, chitin, chitosan, chondroitin sulfate, sodium alginate, carboxymethylcellulose, pectin, polysaccharides, polypropylene gylcols, polyethylene glycols,

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polyacetates, liposomes, fatty acid complexes, cyclodextrins, cycloamyloses, clathrates, cycloalkyl amyloses, polyxylose, polylactic acids and combinations thereof.

4. The pharmaceutical composition of claim 1 or 2 wherein the antimicrobial agent is selected from the group consisting of cephalosporins, glycopeptides, penicillins, monobactams, oxazolidinones, lipopeptides, carbapenems, aminoglycosides, β-lactamase inhibitors and combinations thereof.

5. The pharmaceutical composition of claim 4 wherein the cephalosporin is selected from the group consisting of ceftiofur, cefipime, cefixime, cefoperazone, cefotaxime, cefpodoxime, ceftazidime, ceftizoxime, ceftriaxone, cefpirome, cefclidin, cefmenoxime, cefozoprane, and combinations thereof.

6. The pharmaceutical composition of claim 4 wherein the aminoglycoside is selected from the group consisting of amikacin, gentamicin, tobramycin, polymixin-B, streptomycin, kanamycin and combinations thereof.

7. The pharmaceutical composition of claim 4 wherein the glycopeptide is selected from the group consisting of vancomycin, dalbavancin, oritavancin and combinations thereof.

8. The pharmaceutical composition of claim 4 wherein the carbapenem is selected from the group consisting of meropenem, imipenem, MK0826, R-115,685, J-114,870 and CP5068.

9. The pharmaceutical composition of claim 4 wherein the monobactam is aztreonam or carumonam.

10. The pharmaceutical composition of claim 4 wherein the penicillin is piperacillin or amoxicillin.

11. The pharmaceutical composition of claim 4 wherein the glycopeptide is vancomycin.

12. The pharmaceutical composition of claim 5 wherein the cephalosporin is ceftriaxone.

13. The pharmaceutical composition of claim 4 wherein the lipopeptide is daptomycin.

14. The pharmaceutical composition of claim 1 or 2 wherein the cationic binding agent is selected from the group consisting of calcium, magnesium, lithium, iron, copper, zinc, aluminum, manganese, chromium, cobalt, nickel, ammonium salts and combinations thereof.

15. The pharmaceutical composition of claim 12 wherein the cationic binding agent is calcium.

16. The pharmaceutical composition of claim 12 wherein the cationic binding agent is zinc.

17. The pharmaceutical composition of claim 1 or 2 wherein the cationic binding agent is ionically bound to the biopolymer forming a cationic binding agent-biopolymer complex and the antimicrobial agent is contained within the cationic binding agent-biopolymer complex.

18. The pharmaceutical composition of claim 1 or 2 wherein the cationic binding agent is ionically bound to the antimicrobial agent forming a cationic binding agent-antimicrobial complex and the cationic binding agent-antimicrobial complex is contained within the biopolymer.

19. The pharmaceutical composition of claim 1 or 2 wherein the cationic binding agent is complexed to the antimicrobial and the cationic binding agent is further ionically bound to the biopolymer forming an antimicrobial-cationic binding agent-biopolymer bridge.

20. The pharmaceutical composition of claim 1 or 2 wherein the biopolymer is carrageenan or pectin.

21. The pharmaceutical composition of claim 17 wherein the carrageenan has a calcium content of less than about 0.4% by weight.

22. The pharmaceutical composition of claim 2 wherein the biopolymer is carrageenan, the antimicrobial agent is

ceftriaxone, the metal cation is calcium and the absorption enhancer is capmul.

23. The pharmaceutical composition of claim 1 or 2 wherein the cationic binding agent is selected from the group consisting of cationic polymers, metal cations, basic amino acids, quaternary ammonium salts, and combinations thereof.

24. The pharmaceutical composition of claim 21 wherein the cationic binding agent is a cationic polymer.

25. The pharmaceutical composition of claim 21 wherein the cationic binding agent is a basic amino acid.

26. The pharmaceutical composition of claim 21 wherein the cationic binding agent is a quaternary ammonium salt.

27. The pharmaceutical composition of claim 21 wherein the cationic polymer selected from the group consisting of poly(allylamine), poly-(L-lysine), poly-(L-arginine), dodecyl trimethyl ammonium bromide, polyethylenimines (primary, secondary, and tertiary), and combinations thereof.

28. The pharmaceutical composition of claim 21 wherein the basic amino acid is selected from the group consisting of arginine, lysine, histidine, and combinations thereof.

29. The pharmaceutical composition of claim 21 wherein the quaternary ammonium salt is selected from the group

consisting of benzalkonium derivatives, cetyl pyridinium derivatives, dodecyl-trimethyl ammonium salt derivatives, tetradecyl-trimethyl ammonium salt derivatives, cetyl-trimethyl ammonium salt derivatives, and combinations thereof.

30. The pharmaceutical composition of claim 25 wherein the biopolymer is carrageenan, the antimicrobial is ceftriaxone, and the cationic molecule is arginine.

31. The pharmaceutical composition of claim 25 wherein the biopolymer is carrageenan, the antimicrobial is ceftriaxone, and the cationic molecule is lysine.

32. The pharmaceutical composition of claim 1 or 2 wherein the biopolymer is carrageenan, the antimicrobial is ceftriaxone, and the cationic binding agent is cetyl pyridinium chloride.

33. The pharmaceutical composition of claim 2 wherein the biopolymer is carrageenan, the antimicrobial agent is daptomycin and the cationic binding agent is calcium.

34. The pharmaceutical composition of claim 1 further comprising an absorption enhancer.

35. The pharmaceutical composition of claim 32 wherein the absorption enhancer is selected from the group consisting of a monoglyceride of a C_{12}-C_{18} fatty acid, a diglyceride of

a C_6-C_{18} fatty acid, a triglyceride of a C_{12}-C_{18} fatty acid, gelucire and mixtures thereof.

36. An enterically coated tablet or capsule comprising the pharmaceutical composition of claim 1 or 2.

37. A suspension comprising enterically coated particles wherein the particles comprise the pharmaceutical composition of claim 2.

38. The composition of claim 2 wherein the absorption enhancing agent is an agent selected from the group consisting of lipids, gelucire, capric and caprylic acids, oleic acids, palmitic acids, stearic acids and Capmuls.

39. A method for treating an animal comprising administering to an animal in need thereof a pharmaceutical composition comprising a biopolymer, an antimicrobial agent entrained within or ionically bound to the biopolymer, and a cationic binding agent entrained within or ionically bound to the biopolymer or the antimicrobial agent.

40. The method of claim 40 wherein the pharmaceutical composition further comprises an absorption enhancing agent.

41. The method of claim 39 further comprising administering to said animal an absorption enhancing agent.